Low-^{18}O Meteoric-Hydrothermal Signatures in Groundmass and Fiamme of Fossil Fumaroles of the 0.76 Ma Bishop Tuff, California

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A 150-m thick $\delta^{18}O$ profile of whole-rock (WR) samples from an area of fossil fumaroles in the Bishop tuff at Owens River Gorge shows a low-^{18}O horizon sandwiched between an essentially unwelded upper portion and a densely-welded lower part displaying magmatic $^{18}O/^{16}O$ (see figure). Shallow-dipping columnar joints (sdcj) are correlative with the low-^{18}O horizon, the base of which is extremely sharp (~3 per mil per meter). Detailed sampling of two fumaroles shows that in both cases $\delta^{18}O$ values are lowest at the centers of the fumarolic structures with the larger fumarole having the lowest $\delta^{18}O$ (–4.9) and the largest volume of ^{18}O-depleted rock. Irrespective of the variation in whole-rock $\delta^{18}O$, quartz and feldspar phenocrysts are found to be very uniform ($\delta^{18}O_{qtz}$ = +8.3 to +8.8, $\delta^{18}O_{feld}$ = +7.2 to +7.6), indicating that, unlike the groundmass, the much less abundant phenocrysts did not undergo post-eruptive oxygen exchange. Because the patterns of ^{18}O depletion correlate with the area of most numerous fumaroles and with recrystallization textures in the tuff, as well as with details of the fumarolic morphology (i.e., locations of mounds, ridges, and shallow-dipping columnar joints), it is clear that fumarolic activity involved high-temperature meteoric-hydrothermal fluids. Additionally, the deeper, more densely welded portions of this ash flow tuff everywhere have $\delta^{18}O$ > +6.4, indicating that this thick underlying zone was relatively impermeable to meteoric H_2O, and was the 'heat engine' that provided the energy for the fumarolic activity. This particular isotopic signature of ^{18}O-depleted groundmass and fiamme coexisting with quartz and feldspar phenocrysts that preserve magmatic $\delta^{18}O$ values *requires* a very short-lived (<50 yrs), high-temperature (>500°C) hydrothermal event involving low-^{18}O meteoric waters. Gazis et al. (1996) observed a similar isotopic signature at the Chegem caldera in the Caucasus Mtns., Russia, and correlated it with an event analogous to that of the historically active (1912-1925) ~600°C fumaroles at Valley of Ten Thousand Smokes, Alaska.